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THE TRANSITION FROM PEAT TO LIGNITE

E.F. Koppe[1] and W. Spackman[2]
[1]Pennsylvania Topographic and Geologic Survey, Harrisburg, Pennsylvania
[2]The Pennsylvania State University, University Park, Pennsylvania

A completely satisfactory distinction between peat and lignite is seldom made in coal classification schemes and often peat is excluded entirely from the category of coal. It is not difficult to understand why this situation exists, but the failure to formally recognize peat as a form of coal has an effect which is lamentable, in that it creates a "no-man's land" between the provinces of the biochemist on one hand and the coal chemist on the other. Few biochemists find it rewarding to work in this fringe area and coal chemists are in general abhorred by the thought of concentrating their efforts in the study of peats.

In contrast with the above, the common absence of an adequate differentiation of lignites (or brown coals) and peats in coal classifications is obviously not to be viewed with alarm. It seems apparent that any such distinction will be an arbitrary one and no great need exists at the moment for establishing a firmly fixed line of demarcation. The analytical data present in the literature contrasting the composition of peats and lignites are useful and often informative, at least in a general way. Among other things, these data show that peats commonly contain significantly higher percentages of moisture and nitrogen. However, few would feel prone to assert that air dried peat is lignite, or that lignite can be produced from peat merely by leaching the nitrogeneous substances from the mass. From this it is evident that such data represent the average effect of the actual changes which occur in the transition from peat to lignite. A true understanding of the transition can hardly be achieved without inspecting the nature of the various individual changes, each of which may affect the average moisture, nitrogen or carbon content in a different manner. The materials undergoing the changes are the minerals which are composed of inorganic substances and the macerals which are fabricated of organic material.

The mineral substances present in coal seams occur in discrete masses which usually possess well-defined boundaries by virtue of their mode of origin. Equally discrete are the masees of material formed of maceral substances and, as in the case of the mineral masses, the discreteness obtains because of the manner in which the substance or aggregate of substances has been formed. In some instances these boundaries are inherited from the source materials as in the case of detrital rock fragments and fragments of cell or tissue systems. In other cases, the boundaries are determined by the size and shape of the space in which a newly formed mineral or maceral may be emplaced. Figure 1 of Plate I illustrates this point by showing the clearly defined boundaries of the maceral material which has been formed, in situ, through the alteration of material composing the secondary wall of the vessels. Within the vessel cavity another maceral substance occurs and the size and shape of the mass have been determined by the shape of the cavity and the volume of the intruding material. Comparison of Figure 1 with Figure 2 (Plate I) leaves little doubt as to the in situ development of the buff colored, anisotropic maceral material which now makes up the remnant of the original vessel wall. The latter was initially colorless and has taken on the buff hue during coalification in the peat stage.

The evolution of maceral substances in the peat - lignite transition can be observed readily but little is known concerning the chemistry of these changes. Certain of the materials composing peat are typically stable during the transition, as suggested by the photomicrographs presented as Figures 3 and 4 of Plate I. The illustrations indicate that fusinite as well as certain anthraxylous macerals belong in this category. The observations made thus far suggest that essentially all of the maceral suites possess macerals which are usually stable through this transition.

Although many materials appear to be common to lignites and peats, comparative studies make equally obvious the numerous changes which contribute to the general properties taken on by the newly formed coal type. Plate II depicts some of the organic substances encountered in peat. These include a great variety of materials ranging from colorless and chemically unaltered substances on the one hand to drastically modified opaque and highly colored macerals on the other. As is to be expected, the colorless organic substances are uncommon in lignitic coals but are commonly encountered in thin sections of peat. Lignified and suberized tissues yield a number of materials, some of which appear to provide lignites with their slacking properties. Several of these develop out of the colorless materials encountered in peats and the resultant macerals may be buff, yellow-brown, red-brown or brown in color. Maceral materials of the buff and brown types do not appear to contribute to the slacking of lignitic masses. The bulk of the yellow-brown and red-brown materials are physically disrupted when placed in a dessicating environment, whereas masses of material composed of buff or brown maceral substances remain unaffected.

Tannic and phenolic substances are conspicuous in many peat types and the latter group of materials or their derivatives appear as reddish and brownish macerals in lignites (compare Plate I, Figure 1 with Plate II, Figure 2). The fate of the brilliant red tannins is not clear but in this investigation they have not been observed to occur as such, in other than peat masses. Crystalline inclusions which are found in the cells of a variety of plants appear to be destroyed in the peat environment for, so far as could be determined, they have not been observed in lignitic coals.

With respect to the mineral content of peats and lignites, the most interesting contrast appears to be that associated with the occurrence of pyrite. This mineral is a common component in lignite seams and in other coal beds of higher rank. It is often present in microscopically visible masses and as such is readily detected. In the peats examined, pyritic material is conspicuous by its absence. Although detailed studies have not been made, it seems evident that if pyritic material is present in the peats being studied, it is disseminated in minute particles within the organic substances. The more conspicuous masses previously referred to must be developed during or subsequent to the peat - lignite transition.

Burial of a peat mass beneath a thick cover of other sedimentary materials normally results in the thinning of the peat seam, largely through the loss of water. This presumably includes the loss of both "inter-particle" water and "intra-particle" water. The removal of the inter-particle water obviously places adjacent particles in more intimate contact and causes them to adhere to one another to a certain extent. Wherever plastic substances are present the coherency of the mass is increased and it is further augmented by the "matting effect" encountered in peats containing sizeable concentrations of fibrous material. A truly coherent or "consolidated" mass cannot be produced until the bulk of the material is altered to maceral substances which will behave plastically under the impact of the forces produced by the weight of the overburden. It seems reasonable to assume that the plastic deformation of an individual mass results in an increased adhesion with adjacent particles and an "inter-lacing" of particles through the actual flowage of material into inter-particle spaces. The actual impregnation of a foreign particle by a mobile material appears to be restricted to migration into any voids which may be present in the gross structure of the invaded particle. No evidence was found suggesting an "inter-molecular" mingling of the invading and invaded substances, hence, this type of impregnation is not thought to play a major role in the forming of consolidated coals.

The size, shape and texture of the discrete masses of material comprising lignite seams provide evidence as to which of the macerals have had a plastic phase in their history. Of the macerals derived from lignified or suberized source materials certain of the buff, yellow-brown and red-brown macerals appear to show the greatest effects of having been plastic or mobile at some stage in their development. Volumetrically these materials comprise the larger part of most lignite seams. It seems possible, therefore, that the development of these macerals or their plastic progenitors is essential to the consolidation of a coal seam. If they fail to develop, a poorly consolidated mass of "brown coal" results. Their development appears to be characteristically associated with the peat - lignite transition. Macerals which exhibit plastic properties under the normal pressure conditions encountered in coal measure strata are undoubtedly present in higher rank coals but the above mentioned materials are apparently of primary importance in bringing about the initial consolidation of a coal seam.

All of the preceeding implies that it is profitable to view coal seams as a mixture of macerals and minerals. The rank, the degree of consolidation, the slacking properties and all other characteristics are then a function of the relative concentrations of the constituent macerals and minerals. The importance of understanding the physical and chemical nature of these components and the properties of the natural maceral assemblages is self-evident and research in this field should be accelerated in the interests of achieving the greatest benefits from the exploitation of our coal reserves.

Figure 1: Transverse section of lignitized wood (Persea sp.) from the Brandon lignite. Vessel walls are composed of a buff-colored anisotropic material. (410x)

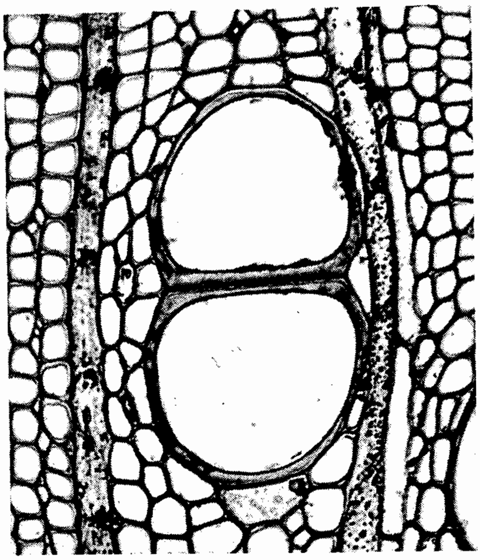

Figure 2: Transverse section of wood of Persea borbonia. Vessel walls are colorless. (310x)

Figure 3: Section of peat from Okefenokee Swamp, Georgia. Opaque fusinite is shown in lower right, yellow-brown to reddish anthraxylous material occupies remainder of photograph. (112x)

Figure 4: Section of lignite from Harding County, S.D. Opaque fusinite is shown in lower right, yellow-brown to reddish anthraxylous material occupies remainder of photograph. (95x)

PLATE I

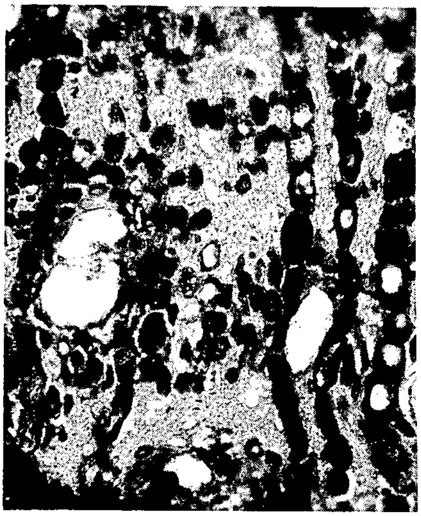

Figure 1: Thin section of materials encountered in peat from Okefenokee Swamp, Ga. (20x)

Figure 2: Wood from peat of Shark River area, southern Florida. Brown phenolic substances in rays are inherited from source material. (84x)

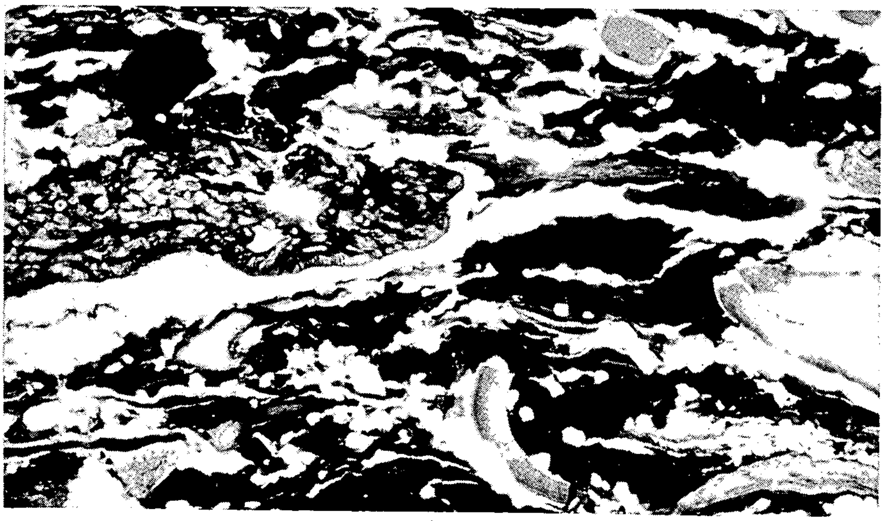

Figure 3: Typical assortment of substances composing Nyssa swamp peat. Materials vary from colorless to a variety of yellow-brown, red, and opaque materials. (27x)

PLATE II